# Technical Alignment and Portfolio Prioritization (TAPP)

*Advanced Methods in Strategic Analysis, Technology Forecasting and Long Term Planning for Human Exploration and Operations, Advanced Exploration Systems and Advanced Concepts*

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## Abstract

The Advanced Concepts Office (ACO) at NASA, Marshall Space Flight Center is expanding its current technology assessment methodologies. ACO is developing a framework called TAPP that uses a variety of methods, such as association mining and rule learning from data mining, structure development using a Technological Innovation System (TIS), and social network modeling to measure structural relationships. The role of ACO is to 1) produce a broad spectrum of ideas and alternatives for a variety of NASA's missions, 2) determine mission architecture feasibility and appropriateness to NASA's strategic plans, and 3) define a project in enough detail to establish an initial baseline capable of meeting mission objectives

ACO's role supports the decision-making process associated with the maturation of concepts for traveling through, living in, and understanding space. ACO performs concept studies and technology assessments to determine the degree of alignment between mission objectives and new technologies.

The first step in technology assessment is to identify the current technology maturity in terms of a technology readiness level (TRL). The second step is to determine the difficulty associated with advancing a technology from one state to the next state[i]. NASA has used TRLs since 1970[ii] and ACO formalized them in 1995[iii]. The DoD, ESA, Oil & Gas, and DoE have adopted TRLs as a means to assess technology maturity. However, "with the emergence of more complex systems and system of systems, it has been increasingly recognized that TRL assessments have limitations, especially when considering [the] integration of complex systems.[iv]"

When performing the second step in a technology assessment, NASA requires that an Advancement Degree of Difficulty (AD2) method be utilized. NASA has used and developed or used a variety of methods to perform this step: Expert Opinion or Delphi Approach, Value Engineering or Value Stream, Analytical Hierarchy Process (AHP), Technique for the Order of Prioritization by Similarity to Ideal Solution (TOPSIS), and other multi-criteria decision making methods. These methods can be labor-intensive, often contain cognitive or parochial bias, and do not consider the competing prioritization between mission architectures.

Strategic Decision-Making (SDM) processes cannot be properly understood unless the context of the technology is understood[v]. This makes assessing technological change particularly challenging due to the relationships "between incumbent technology and the incumbent (innovation) system in relation to the emerging technology and the emerging innovation system.[vi]" The central idea in technology dynamics is to consider all activities that contribute to the development, diffusion, and use of innovations as system functions[vii]. Bergek defines system functions within a TIS to address what is actually happening and has a direct influence on the ultimate performance of the system and technology development. ACO uses similar metrics and is expanding these metrics to account for the structure and context of the technology.

At NASA technology and strategy is strongly interrelated. NASA's Strategic Space Technology Investment Plan (SSTIP) prioritizes those technologies essential to the pursuit of NASA's missions and national interests. The SSTIP is strongly coupled with NASA's Technology Roadmaps to provide investment guidance during the next four years, within a twenty-year horizon. This paper discusses the methods ACO is currently developing to better perform technology assessments while taking into consideration Strategic Alignment, Technology Forecasting, and Long Term Planning.

[i] NASA Systems Engineering Handbook SP-2007-6105

[ii] Fernandez, J. A. (2010). Contextual Role of TRLs and MRLs in Technology Management. Sandia National Laboratories, SAND2010-7595.

[iii] J. Mankins, Technology readiness levels, A White Paper, NASA, Washington, DC, 1995

[iv] Fernandez, J. A. (2010). Contextual Role of TRLs and MRLs in Technology Management. Sandia National Laboratories, SAND2010-7595.

[v] Elbanna, S. 2011. Multi-theoretic perspectives of strategy processes, UAEU-FBE-Working Paper Series, Number 2011-09.

[vi] Hekkert, M. P., Suurs, R. A., Negro, S. O., Kuhlmann, S., & Smits, R. E. H. M. (2007). Functions of innovation systems: A new approach for analysing technological change. Technological Forecasting and Social Change, 74(4), 413-432.

[vii] A. Bergek, Shaping and Exploiting Technological Opportunities: The Case of Renewable Energy Technology in Sweden (Thesis), Chalmers University of Technology, Göteborg, Sweden, 2002.